Data Release Addendum

Data Quality Assessment Overview

Detailed information about the Quality Assessment for each data delivery can be found in the QA summary report provided with the data. Note that Level 2A and Level 2B Operational Standard Data Products (OSDP) are based on whole pulse sigma0s. The Level 2B OSDP vector winds are retrieved with the new QSCAT-1 model function.

The primary conclusions of the Calibration phase with regard to the QuikSCAT data quality are listed below. Items 1-7 represent assessments of the Interim data (January 31, 2000 release) as well as preliminary characterization of the Operational Standard Data Products. These analyses began prior to the November, 1999 SeaWinds/QuikSCAT calibration workshop and are continuing.

1. Based on open-ocean analyses, the V-pol (outer) and H-pol (inner) backscatter measurements are relatively calibrated to within 0.1 dB.

2. The occurrences of negative σ_o measurements over the ocean are within expectations and are correlated with low wind speeds. The fraction of negative σ_o measurements varies between 0.2% and 1.0% for individual revs, averaging around 0.5% globally.

3. Preliminary analysis suggests that QuikSCAT σ_o and vector wind measurements are accurate within approximately one cell (~ 25 km) of the coastline. The land mask has a seaward extension of 30 km from the land found in the original NORDA 1 min map.

4. Comparisons with NCEP operational surface wind analyses and NDBC buoys show that the SeaWinds/QuikSCAT winds have ~1.4 m/s rms accuracy for speeds from 3-20 m/s. Directional accuracies vary as a function of wind speed (as expected from an error model incorporating random component errors), with overall rms differences of 14 degrees for speeds from 5-20 m/s and 18 degrees for winds from 3-20 m/s. Model function refinements implemented in the QSCAT-1 model function used to process the L2B OSDP correct observed distortions of the directional histograms and give a 0.3-0.4 m/s apparent wind speed bias (SeaWinds/QuikSCAT high) relative to NWP winds. The latter addresses the observed under-prediction of wind speed inherent in the NWP products

5. Ambiguity removal using the QuikSCAT data with the NWP nudging algorithm (initialized using the NCEP 2.5 degree resolution global analysis nearest in time to the data) averages 90-95% skill when compared against interpolated NCEP and ECMWF analyses for speeds from 3-30 m/s; the skill exceeds 95% for speeds above 10 m/s. Some variations in overall wind retrieval performance as a function of cross-track location are observed, resulting from the conical scan geometry of the instrument.

6. Two vector wind selections are given in the L2B product (see the L2B Software Interface Specification (SIS)). The value in variable *wvc_selection* indicates which of the (four or fewer) solutions resulting from the standard maximum likelihood wind retrieval scheme was selected by the ambiguity removal algorithm. The vector wind values in variable *wind_speed/dir_selection* are from the Direction Interval Retrieval Threshold algorithm (DIRTH) developed by B. Stiles. The DIRTH retrievals have been improved from those in the Interim data products by using a finer search interval in angle. This removes some features that were observed in the directions of DIRTH solutions. Information on the DIRTH algorithm and its implementation can be found in the documentation on the PO.DAAC web site http://podaac.jpl.nasa.gov/quikscat. Users who want the speed and direction originally retrieved should use the index in *wvc_selection* to select from the set of values in *wind_speed/dir*.

7. Brightness temperature (Tb) estimates calculated from processing QuikSCAT signal and noise measurements are included in L2A Operational Standard Data Products. The Tb algorithms and calibration in the OSDP represent a significant improvement over the preliminary estimates in the Interim data products. Tb is computed on a pulse-by-pulse basis. The pulse Tbs are grouped along with the sigma0s in L2A processing, and all the values for the inner (H-pol) and outer (V-pol) beams are averaged to two single values that are included in the L2A product (*mean_wvc_tb_in/out*) along with the number of values averaged (*num_wvc_tb_in/out*) and the standard deviation about the average (*std_wvc_tb_in/out*).

8. Observations of apparent rain contamination were presented and discussed at the November, 1999 cal/val workshop. These observations led to an intensive effort to develop autonomous rain indicators. Indices from two such algorithms are included in the L2B OSDP. The *nof_rain_index* covers the swath where both H and V polarization data are available, while the *mp_rain_probability* covers the entire swath. The *mp_rain_probability* uses eight parameters, including the *nof_rain_index* and the average brightness temperatures, to find the probability that the rain rate is greater than 2 km*mm/hr. The *mp_rain_probability* is used to set bits in the L2B variable *wvc_quality_flag* indicating both the detection of rain and the quality of data available for rain flagging for that wind vector cell.

Preliminary analysis indicated that incorrect indications of rain (“false alarms”) often occur as isolated cells. In the Operational Standard Data Products, spatial filtering is used to reduce the frequency of these false alarms. A five-by-five window around each flagged wind vector cell is checked for other flagged cells. If fewer than four (4) other wind vector cells in the window are flagged, the center (isolated) wind vector cell *mp_rain_probability* value is checked against a higher threshold than is used to set the flag originally.

In addition to the rain flag, the provision of rain index values allows investigators to experiment with different thresholds. Where collocated data exist, overlays of rain rate from SSM/I are available as a separate product.

The rain indices and flag are more fully described in the L2B SIS and in separate algorithm documentation available on the PO.DAAC web site. The index and flag algorithm implementations have been tuned to spatially and temporally collocated SSM/I rain data, and represent a compromise between maximizing rain detection and minimizing false alarms (index or flag indicates rain when SSM/I does not show rain). As implemented in the processing for the Operational Standard Data Products, approximately 5% of global data is flagged as rain.

Data Formats, Flagging Conventions and Recommended Flag Usage

In keeping with NASA Earth Observing System Data and Information System policy, the SeaWinds/QuikSCAT standard data products are produced in Hierarchical Data Format (HDF) format. Each distributed data tape includes documentation for the product(s) as well as fully tested and well-commented sample read programs in several computer languages (e.g., FORTRAN and IDL). The documentation is also available from the PO.DAAC web site at
http://podaac.jpl.nasa.gov/quikscat

While the data products are comprehensive and HDF allows relatively efficient extraction of subsets of the variables, investigators are urged to study the Software Interface Specifications and product Users Guide to assure that all relevant data are being extracted, that proper ambiguities are being examined (for the vector wind L2B product), and especially that the information in all quality flags is being used as intended to select the data upon which analyses are based. The following descriptions, abstracted from the SIS documents, are highlighted to aid users in interpreting quality flags properly.

1. QuikSCAT Flagging Conventions [From L2B SIS, p.8: 1.6.7 Bit Flag Conventions]

At the start of processing, all QuikSCAT bit flag values are initialized. The standard procedure for QuikSCAT initialization of bit flags sets all defined bits to 1 and all undefined bits to 0. Bits are reset to 0 when data pass the indicated test. If the Level 2B Processor detects an anomalous condition which halts the processing for a particular wind vector cell, the appropriate bit flag which indicates the error condition remains set to 1. Since the processor may curtail subsequent operations for the wind vector cell that failed the test, those bit flags which normally would be tested in subsequent code also retain their initialized value. Thus, the order in which bit flags are processed determines whether their values are meaningful.

For instance, if wvc_quality_flag indicates that there is poor azimuth diversity among the sigma0s in a wind vector cell, the Level 2B Processor does not retrieve winds for that cell. Since wind retrieval does not take place, the code can not determine whether wind solutions for that wind vector cell are within or outside of the optimal range. Thus, the bits which represent the presence of either high and low wind speeds in the wind vector cell remain set to 1. These settings indicate neither a high nor a low wind speed. Users should ignore these

values. On the other hand, the remaining bits in the wvc_quality_flag do contain valid values. These bits are valid because they were determined before the Level 2B Processor halted processing for the associated wind vector cell.

As indicated in the flagging convention, the best data will usually have flags equal to 0; however, that may not be reasonable in all cases, particularly for informational flags. This section indicates the key flags for each data level, flag settings for the best ("cleanest") data, and what bits may be allowed for usable data. Again, users should refer to the SISs or Users Guide for additional detail on flag bits and flag usage.

2. Level 2B – ocean vector winds in wind vector cell grid

The L2B data set is the most highly processed standard product and has the simplest flagging.

wvc_qual_flag (L2B SIS 3.5.68): This flag will be 0 for the best data. The key bit is bit 9 indicating that wind retrieval was performed. A value of 1 for bit 9 indicates that no wind retrieval was performed, and therefore no ambiguities were calculated (variable "num_ambigs"=0) nor was any ambiguity chosen by an ambiguity removal algorithm ("wvc_selection"=0).

The coastal (bit 7) or ice edge (bit 8) flags will be of interest to investigators attempting to work close to land or ice. These advisory bits are set if any part of the wind vector cell was over land or ice, respectively, even though sufficient good ocean sigma0 measurements were available in the wvc to retrieve winds.

While accuracy requirements do not apply outside the 3 to 30 m/s range indicated by the high (bit 10) and low (bit 11) speed flags, and preliminary analysis shows that these winds have larger differences from NWP models, there is nothing inherently wrong with winds with the speed flags set. It is, however, suggested that winds below 1 m/s be used with great caution. Also, as is well known, the model function has had less development and previous correlative validation measurements are rare above about 20 m/s.

Rain flagging bits: Bit 12 indicates whether the rain flag bit 13 is usable. Thus, bit 12 clear (0) and bit 13 set (1) is a valid indicator of rain, while both bits clear is a valid indicator of no apparent rain exceeding the threshold.

Data availability: Bit 14 indicates whether all four instrument "views" (inner and outer beams looking fore and aft of the spacecraft) were available; this will always be 1 (invalid) in the outer swath as only the outer beam (V-pol) is available.

wvc_selection (L2B SIS 3.5.71): The variables "wind_speed" and "wind_dir" contain speed and direction information for up to four ambiguities for each wind vector cell. As noted in the SIS and Users Guide, the ambiguities are listed in decreasing likelihood order. The variable "wvc_selection," if non-zero, contains a pointer (values 1 to 4) to the ambiguity selected by the ambiguity removal algorithm. *Therefore, the first-listed ambiguity in "wind_speed" and "wind_dir" does **not** correspond automatically to the chosen ambiguity*. Cells with wvc_selection=0 have no ambiguity selected and should be excluded from comparisons and most statistics.

Notes on other variables in the L2B data

The Level 2B products contain two ambiguity selections: the first, indicated by *wvc_selection*, is one of the retrieved ambiguities as selected by the baseline ambiguity removal algorithm (median filter with NWP "nudging," similar to NSCAT). The second is from the Direction Interval Retrieval with Threshold Nudging (DIRTH) algorithm and is reported in *wind_speed/dir_selection*. If no DIRTH solution is available, the selected ambiguity is copied into those elements. The DIRTH winds appear improve QuikSCAT performance significantly in the nadir region while making only small changes over the rest of the swath. Please read the additional description of these values found in the documentation area of PO-DAAC QuikSCAT web site.

The L2B data set contains nudge field wind speed (*model_speed*) and wind direction (*model_dir*) estimates for each valid wind vector cell. These speed and direction values are derived from the available operational NCEP global 2.5 deg resolution, 1000mb analysis closest in time to the QuikSCAT overpass at the geographical location of the wvc. They represent spatially, but not temporally, interpolated winds. Wind speeds are estimates for the 1000 mb level – they are ***not*** 10 m wind speeds. Comparisons between the QuikSCAT wind velocity estimates and the "model" wind velocity estimates contained in the L2B data provide only an exceptionally crude indication of the accuracy of the QuikSCAT winds.

The *atten_corr* variable in the L2B product contains a single, representative value for the atmospheric attenuation in each wvc. The actual attenuation corrections applied to each backscatter measurement in a wvc (from a monthly average map) prior to wind retrieval can be different from the single *atten_corr* value.

3. Level 2A – Sigma0 data in wind vector cell rows tagged by WVC

sigma0_mode_flag (L2A SIS 3.5.59): This flag gives information on each sigma0. It propagates some of the information from frame_inst_status to individual sigma0s. Many of the bits will normally be non-zero.

sigma0_qual_flag (L2A SIS 3.5.60): This is the key flag for sigma0 quality. Note the dependencies table in the SIS. For good data it will =0, except, perhaps, for the negative sigma0 flag in bit 2. Because of the noise subtraction process, it is possible to obtain an estimate of signal power which is < 0 giving a negative sigma0. Since most sigma0s are fractional, they are represented as negative in dB. Thus to indicate an estimate of negative signal power, bit 2 is set. These are valid measurements from very low backscatter areas (low wind speed, land, etc.). Data with low SNR (third bit) may also be valid, but are of lesser quality.

Please read the additional description of these values, and other informative material, found in the documentation area of PO.DAAC QuikSCAT web site.